United States District	**Forest**	**Wallowa-Whitman**	**La Grande Ranger**
Department of Agriculture	**Service**	**National Forest**	**3502 Highway 30 La Grande, OR 97850**

Date: 9/14/2020

Subject: Sheep Creek Vegetation Management Project – Effects Anaylsis

To: Sheep Creek IDT

The purpose of this report is to describe the effects analysis for the Sheep Creek Vegetation Management Project area.
Information sources used to complete this report include:

- Analysis of direct and indirect effects for the Sheep Creek project.

Proposed Project Location

The La Grande Ranger District, Wallowa-Whitman National Forest, manages the proposed project located at Township 5S and 6S, Range 35E, approximately 22 air miles southwest of La Grande, OR. The project boundary spans both the Chicken Creek and Sheep Creek Subwatersheds, which both drain into the Upper Grande Ronde River. This project is accessible by National Forest System Road (NFSR) 51 to the East and NFSR 5160 to the Northwest.

The project area, approximately 29,935 acres, is located entirely within Union County and divided by private land.

Introduction

There are several factors in the Sheep Creek Analysis Area that affect overall integrity as described by the Watershed Restoration and Prioritization Process (WRAPP) developed by the Wallowa-Whitman National Forest (2002). Stressors indicated by WRAPP include Fire Regime, Insect and Diseases, Noxious Weeds, Road/ Stream Connectivity, Road/ Wildlife Security. The risk of fire and insect and disease are major silvicultural concerns to implementing the Wallowa-Whitman Forest Plan and ecosystem management. To restore and maintain the landscape, silvicultural means should be used to modify and rejuvenate the forested landscape in the analysis area.

Analysis Assumptions

The project area is approximately 36 air miles from La Grande, Oregon. The 29,935 acre project area is the analysis area for analysis of direct and indirect effects. The cumulative effects analysis includes Chicken Creek and Sheep Creek subwatersheds.

To restore and maintain the landscape, silvicultural treatments can be used to modify forest structure and composition and rejuvenate the forested landscape in the analysis area. Cutting prescriptions such as Improvement cuttings or commercial thinning are types of silvicultural methods that can improve landscape health, reduce the risk of insects, diseases, and wildfire (Powell 1999, Graham et.al. 1999, Millar 2007, Kimbell 2007, policy statement 2007, Brown 2008, Strategic Framework 2008). Treatments can provide a range of structures for the long term, release potential of the sites, and alter species composition. Taking management actions that lead to resiliency in the face of disturbance is one way to mitigate the effects of climate change.

Stand and landscape attributes such as density, forest structure and species composition within the historic range of variability make the landscape more resilient and resistant to disturbances. Over the last century shifts in species composition and density have created vegetative conditions where insects, diseases, and wildfire may operate in uncharacteristic levels (Morgan and Parson, 2001).

Insects and diseases can cause growth reduction, mortality, defect, and decay. On an ecosystem health basis, a certain level of tree insect/disease activity is expected (Schmitt 1994). Trees may be susceptible to attack by insects or diseases by various factors including fire, overstocking, drought conditions, and the existing level of insects and diseases within the area. Stand density is one of the most important factors influencing certain insect populations; dense stands increase tree competition, which increases stagnation and development of a suppressed class of trees, which can lead to outbreaks (Scott 1996, Powell 1999). Another important factor to spread of insects/diseases is species composition. Current philosophy is to manage the level of insects/diseases and their affects, to within the range that is believed historical (Schmitt 1994). Most root diseases are believed to have increased in their virulence and occurrence in the Blue Mountains (Schmitt 2001).

Many stands in the Sheep Creek Planning Area have suppressed and intermediate trees and stocking levels exceed recommended numbers (from Powell, 1999) in stands across all potential vegetation groups. Overstocking and poor tree conditions can lead to an increase in beetle populations, reduced health of the stand, decreases in production of both the overstory and understory, and alter stand structures and compositions. In many instances stress, particularly drought stress, is compounded by overstocking (Fiddler et al., 1995). This stress can lead to losses in tree growth and increases in insect and disease caused mortality. Appropriate stocking levels can help to increase tree growth and fire, insect, disease resistance of stands (Lambert 1994). The number of stands treated would measure the effectiveness of the alternatives towards reducing stand density and changing species composition.

Climate change is expected to bring temperature increases and changes in long-term trends in precipitation (Halofsky and Peterson 2017). Disturbances from pest, diseases and fire are projected to have increasing impacts on forests resulting from the changing climate. Climate change most typically is predicted to increase fire, drought, and greater vulnerability to insects and diseases in forests (Brown 2008). Insect life cycles are highly sensitive to temperature; climate change can have a large impact on the development, survival, and distribution of insects (Redmond 2007, Brown 2008). Recent warming trends have caused mountain pine beetle infestations in areas that have not previously recorded outbreaks in British Columbia and this increase has occurred largely in part due to a shift in climate (Carroll 2004, Beukema et.al. 2007).

The impacts of climate change on most terrestrial ecosystems are expected to occur at a rate that would exceed the capacity of many plant and animal species to migrate or adapt (Kimbell 2007; Strategic Framework 2008) and create forests that are ill adapted to conditions and more susceptible to undesirable changes (Millar 2007). To restore and maintain the landscape, silvicultural means should be used in the project area to modify and rejuvenate the forested landscape, improve landscape health, reduce the risk of insect mortality and wildfire, begin to provide a range of structures for the long term, release potential of the sites, and alter species composition (Millar 2007, Kimbell 2007, Policy Statement 2007, Brown 2008, Strategic Framework 2008).

Proposed Action

Treatments proposed under this project will be designed to move stands from their current structure and development trajectory to conditions that more closely reflect natural disturbance regimes. Strategies for restoring forest structure and function include thinning trees and prescribed burning of surface fuels to reduce potential fire intensity and severity.

Long term vegetation management objectives for the analysis area include:

1. Restoring and maintaining vegetative conditions and wildlife habitats consistent with the historic range of variation in terms of vegetation composition, structural stages, and disturbance patterns (fire regimes).
2. Creating and maintaining fuel profiles within the project area that minimize risk to firefighter safety, public, adjacent private and county lands, natural resources, and developed lands in the event of a wildfire.
3. Creating and maintaining vegetative conditions that are more resistant and/or resilient to anticipated increases in fire frequency and severity due to climate change.

Development

Vegetation management is proposed in the project area to create and maintain vegetative conditions that are more resistant and/ or resilient to disturbances. Areas proposed for treatment meet all the following criteria:

1. **Treatment area occurs on previously managed stands.**
   Most proposed action treatments occur within a stand that has been previously commercially harvested or non-commercially harvest and/or a fuels reduction treatment. Units that appear to have no previous management have large diameter stumps throughout the unit indicating management that was not recorded by the Forest Service.

2. **Treatment areas are adjacent to existing open and closed roads for unit access.**
   No specified roads will be required to implement the proposed action. Utilizing current open roads, opening closed roads, and constructing temporary roads will adequately provide access to the proposed actions. Proposed management unit’s

proximity to a major road prevent these areas from functioning as satisfactory security or forage habitat for big game species; and treatment would not change this. In addition, these stands are at an elevated risk to fire ignition due to their proximity of heavily used 3-season road compared to other areas within the project area.

3. **Treatment areas occur on soil types and topographic positions that are likely to experience droughty conditions into the future.**
   Map of the droughty soil probability layer which identifies soil types that have a thin organic layer, a high bulk density, and of a parent material that inherently decreases available water capacity. Available water capacity is the maximum amount of plant available water soil can provide. Areas with droughty soil probability greater than 60% will not be able to provide water for plants during drought. Lack of available water decreases plant vigor and will reduce the plants ability to defend itself from insect attacks. Areas within the project area that have a high probability of having no available water in the soil during drought suggest less vegetation is appropriate. In addition, drought tolerant species have a competitive advantage growing on these soil types than other species.

4. **Treatment is targeted to be in or proximity to fire regime condition class 1 or 2. Treatment not meeting this criterion falls within a strategic fuel break. Treatment is aimed at creating conditions that are conducive to fire behavior that is low severity.**
   Fire suppression has effectively stopped fire from recently (within the last 100 years) entering the project area with the exception of portions of the Boundary fire, the Tower fire and Chicken Hill fire. . The stands in the project area are at a higher ignition risk due to its close proximity to a major road.The majority of commerical treatments occur in areas where the expected fire behavior is high frequency and low severity. Treatment areas in expected fire regime condition class 3 (mostly non-commerical), are directly adjacent to Dry Upland Forest, with expected fire regime 1 and 2. Existing remnant legacy fire-tolerant western larch and ponderosa pine within stands of the project area further illustrate that large-diameter, widely-spaced, early-seral-species comprised the stand's historical composition, density and structure as a result of past disturbances (fire).

   Johnston (2017) explains that frequent fire across the landscape historically reduced tree biomass on moist sites to equal or less biomass as less productive sites. Fire exclusion has caused more productive grand fir potential forest to experience significantly greater relative change, in regards to density, than ponderosa pine dominated stands with intact old-growth structure in the southern Blue Mountains. The Sheep Creek project area has been simplified by the cumulative effects of past management and fire suppression, creating uncharacteristic regeneration conditions to what historically occurred, including Douglas-fir (mid-seral species) dominance with some grand fir (late seral). Focusing on a future OFSS structure for Sheep Creek project areas is better aligned with climate change adaptation recommendations, increased potential fire ignition exposure, and allows the stand to function largely as the Dry Upland Forest environments surrounding it.

5. Moist upland forest proposed for treatment that meets the criteria above will adopt the same management strategies currently recommended for restoring resilience in dry pine dominated forest- protecting old trees, reducing surface fuels, reducing overall forest denisty, and shifting composition from fire intolerant to fire tolerant species. This strategy will be important for developing resilence across the landscape, because dry and moist mixed conifer forest experienced similar fire disturbance regimes as ponderosa pine stands in the past and are likely to experience similar fire disturbance regimes in the future. Also directional climate change is likely to impose enviromental constraints on moist forest that were historically experienced by drier sites. Finally wildlife use and ecological processes that were historically characteristic of moist mixed confier forest were compatible with lower densities and basal areas than exist today (Johnson, 2017)

Prescription Descriptions
Commercial Fuels Reduction and Vegetation Management Treatments:

HTH – Thinning/ HTH – OFSS/ HTH-BIOMASS/ HTH-UMZ

Thinning from below prescription is designed to reduce competition for site nutrients and concentrates growth potential on residual trees. Three goals of this prescription are:

1. Perpetuating old forest conditions threatened by severe fire from high density of fuels,
2. Bringing forest conditions to higher resilience to drought and insect attacks,
3. Accelerating development of structural complexity and old-growth characteristics in young forest stands

Thinning can improve growing conditions, tree quality, mortality to severe wildfire and economic value of the stand. Residual thinning density varies based on management species, tree sizes, reducing ladder fuels and spacing of the overstory and understory trees. These considerations will help achieve desired heterogeneous spacing distribution (Tappeiner, 2008). Thinning From Below removes smaller over topped trees and some poorly crowned intermediates/ co-dominants which compete for site resources and create ladder fuels into the crowns of the best quality trees which would remain on site. The species composition of a stand can also be influenced by thinning, e.g. depending on which tree species are cut and which are retained. This treatment will create stumps, slash and soil disturbance that will be visible for foreground views. These effects will be minor, lasting the first few years only. As regrowth of shrubs and grasses occur these effects will be significantly reduced. The prescription does not create openings that are visible from middle ground or background distances. HTH-OFSS creates Old Forest Single Stratum (OFSS) structures by thinning in Old Forest Multi Stratum (OFMS) or accelerates the development of UR into late and old structure within the next 10-15 years. HTH, HTH-BIOMASS, HTH-UMZ accelerates the development of stands into late and old structure (as defined in R6 Interim Old Growth definitions).
Acres of OFMS treatment: 167

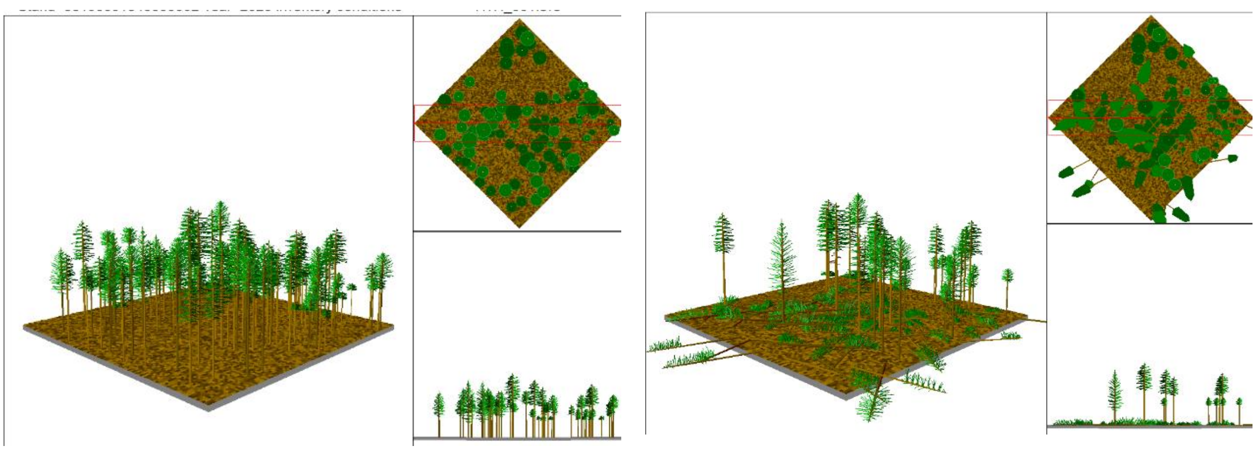


Figure 1- a visual of a HTH harvest, thin from below-removes suppressed, intermediate or poor form trees around dominant and codominant creating less competition for resources on the site such as water or sunlight.

HIM– Improvement Harvest/ HIM – OFSS/ HIM-BIOMASS

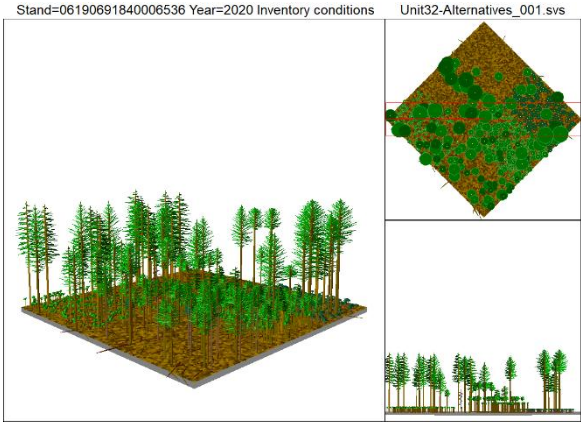
The improvement harvest prescription is designed to:

1. Enhance early seral species composition
2. Improve vigor, condition and form of existing early seral species
3. Reduce disease damage
4. Accelerate development of structural complexity and old-growth characteristics in young stands

Retention of mature fire and drought tolerant trees supports frequent low-severity wildfire, climate-tolerant landscapes, and wildlife habitat while providing essential seed sources for early seral species regeneration. Trees of different size classes will be retained, and residual stocking levels will be near the lower management zone, excluding areas of high disease presence or pure grand fir where densities will may below the lower management zone. Areas in stands where disease is prevalent, particularly mistletoe or annosus root rot, stocking levels will be managed below the lower management zone for associated plant groups to create a physical distance barrier between potential host trees infected with the disease and healthy trees in order to reduce spread of the diseases (Powell, 2014). Dwarf mistletoes often predispose trees to attack from insects or pathogens (Powell, 2014). Grand fir has poor resilience (thin bark, drought intolerant) from insects and fire and will not be promoted through treatment. Grand fir that is retained will be primarily above 21" DBH, because larger diameter grand fir is more resilient to disturbance agents than smaller diameter grand fir (Powell, 2014); or will be retained to maintain canopy cover throughout the stand and provide future snags and meet wildlife objectives. Low stand densities in disease prevalent areas will promote early seral regeneration conditions (Barrett 1979) and may be planted with early seral species that have resistance or are not suspectable to the disease. Cutting intensity will vary for different areas dependent on both biotic and abiotic factors. HIM-OFSS creates Old Forest Single Stratum (OFSS) structures by thinning in Old Forest Multi Stratum (OFMS) or accelerates the development of UR into late and old structure within the next

10-15 years. This prescription creates a natural visual appearance by moving conditions toward its historical range, opening stands to a lower stocking level, and toward a species composition that is within the historical range. The effort to move conditions toward the historical range usually contributes to the improvement of scenic stability and wildlife.

Acres of OFMS treatment: 33 Acres



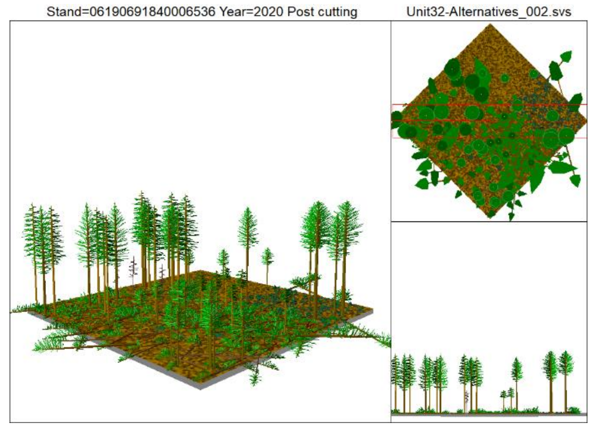


Figure 2- a visual of a HIM, improvement harvest treatment, which removes suppressed, intermediate, poor form or disease infested trees around dominant and codominant creating less competition for resources on the site such as water or sunlight. Areas of high disease presence will have less trees retained decreasing the rate of spread of the disease and creating open growing space for early seral species.

HSH – Two aged Shelterwood Establishment and Removal Cut

The shelterwood harvest prescription facilitates the establishment of a new cohort of trees within root diseased stands that have major implications on forest trajectories. They are considered “diseases of the site,” because once they have established the pathogens survive in buried root material over generations of susceptible hosts (Hatfield et al. 1986). Over time the disease will radiate from an infected stump or tree to infect / kill adjacent hosts. The continuous widening of forest gaps will continue as long as suitable hosts exist. This can effectively “Stall” succession in some systems (Hagel et al.1995). Shrubs typically invade these openings and make it difficult for root disease resistance species to become established. Overstory within these units are dominated by lodgepole pine, subalpine fir and grand fir, with a lesser component of early seral species. This prescription will create the foundation for a two-story stand, the overstory (primarily early-seral species) that are not prone to annosus or armillaria root rot mortality in place as a seed source, and regeneration. All grand fir, subalpine fir and Douglas-fir would be removed from the stand except from within identified Green Tree Retention areas. Following commercial treatment prescribe burning would help with site preparation for natural or artificial regeneration. This harvest would reduce stocking below the minimum stocking and would, therefore, require provisions for establishing new stands and be subjected to created opening constraints. Reforestation methods would be made on a site-by-site basis. Natural regeneration of the desired species composition is desired and managed for; planting would be considered if restocking (of the desired species composition) is not met within five years. Trees within pockets of armillaria and annosus root rot infections may be selected for rootwad extraction and used as large woody debris for future stream restoration projects. This prescription creates a open stand, changing the species composition, forest structure and density.

Figure 3- A visual of Two aged Shelterwood Establishment and Removal Cut, removes all but desired species vigorous trees on a site to create conditions conducive to establishing early seral species. Residual trees would not be removed and stay on site for wildlife habitat purposes.

HPO-Patch openings/ HPO-Biomass/ HBT ENHANCE

Partial openings harvest would occur in stands that are predominately lodgepole pine, with interspersed ponderosa pine, western larch and Douglas-fir. The objective of this prescription is to create openings, promoting early successional structure around early seral species where they exist, as well as creating some heterogeneity in the stands. The remainder of the unit is a matrix of thinned areas and reserves. Patch openings are shaped and blended to the extent practicable with natural terrain. The size of canopy openings will depend on species composition and frequency; as small as a 50 foot radial opening around an individual and no larger than 4-6 acres in size. Canopy openings would occupy no more than 40 percent of the stand. Tree density in thinned matrix areas would be decreased to the associated plant association group’s lower management zone to reduce competition. 10-15 % would receive no treatment to provide for green tree retention areas. Removing portions of closed canopy conditions will: 1. Encourage the development of early seral habitat 2. Promote the development of and increase the resilience to large diameter trees. The patch openings would replicate patterns that appear on the natural landscape- gaps would similar in size, shape and form; which introduces visual diversity to the scene. This is the case especially, where the characteristics of the openings borrow from or repeat nearby patterns, such as wildfire burn scars (Bradley, 1996). Patch opening treatments would create forests with canopy openings that reflect fine-scale disturbances and increase resilience to insects, disease, wildfire and climate

change (Graham et al. 2004). Within patch openings, timber harvest would reduce stocking below the minimum crop tree and would, therefore, require provisions for establishing new stands and be subjected to created opening constraints. Reforestation methods would be made on a site-by-site basis. Natural regeneration would always be considered, and surveyed three times within the first five years to ensure adequate restocking is met. Planting would be considered if restocking is not met after five years. Patch openings transition SE or UR forest structures into SI patches in stands, matrix thinned areas would accelerates the development of UR and SE structure into late and old structure.
future stream restoration projects.
HBT Enhance treatment creates an opening like HPO treatments for the entire treatment area, opening sizes are limited to less than two acres and reflect fine- scale disturbances. This treatment occur in stands in the stem exclusion stage on Dry Upland forest, in order to enhance habitat for wildlife associated open stands containing late and old structure. This treatment occurs in stands in the stem exclusion forest structure stage.
Acres of OFMS treatment: 207 Acres

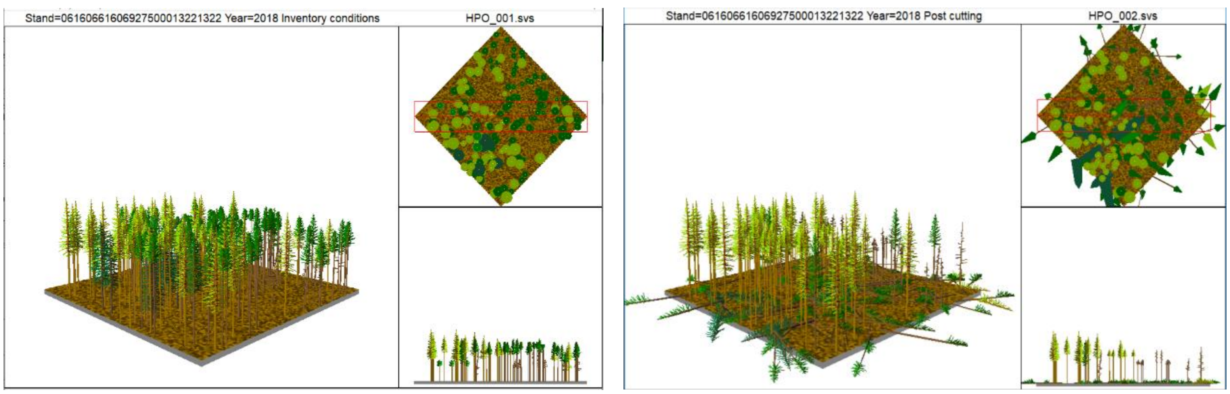


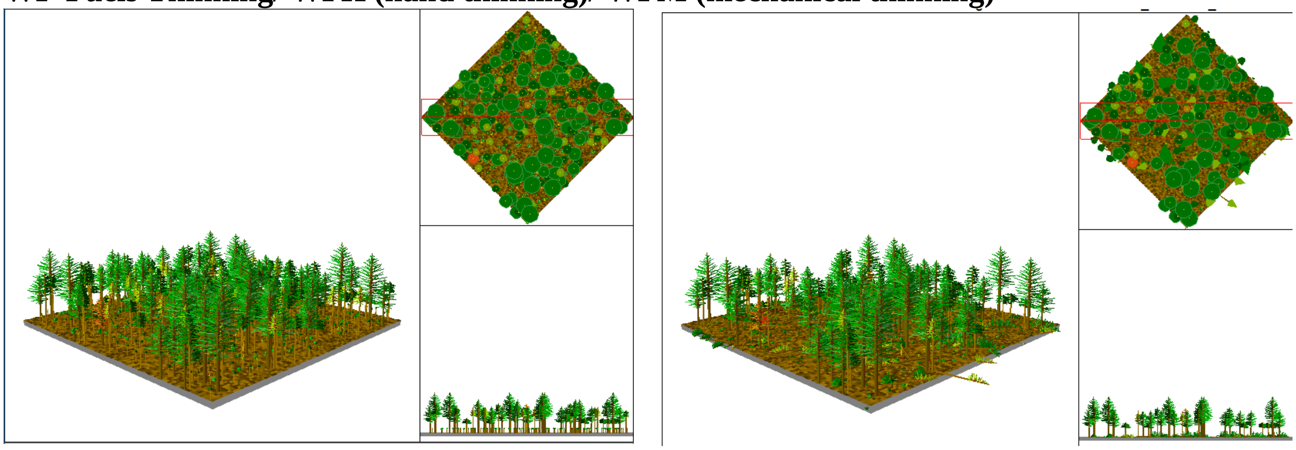
Figure 4- a visual of patch openings treatment, early seral species (western larch is in yellow) are thinned to reduce competition. Pockets of pure lodgepole pine are removed around established early seral species to create conditions conducive for regeneration of early seral species.

Non-commercial Fuel Reduction and Vegetation Management Treatments:

PCT- Pre-commercial thinning PCT-H (hand thinning)/ PCT-M (mechanical thinning)

Thinning of smaller diameter selected trees in a young stand to stimulate the growth of the remaining trees. The primary effect of early PCT work would be to control whether wood volume and growth are concentrated on few large, stable trees or spread over many small, unstable trees (Schaedel, M.S. et al., 2017). The positive effects of PCT are like thinning, however, no commercial products would be removed. The negative effects to scenery are limited to foreground view effects of stumps and slash. Slash may be treated through slash busting, hand-piling and burning which reduces the visual effects to the casual viewer, or is lopped up into small sections and scattered throughout the stand at an average height of 2’ above the ground to help with nutrient cycling. Pre-commercial thinning contributes to scenic stability by reducing stand densities and removing ladder fuels that put scenic attributes at risk to potential wildfires.

WF-Fuels Thinning/ WFH (hand thinning)/ WFM (mechanical thinning)



This is a very similar treatment to PCT; however, the primary objective of this treatment is to reduce fuel loading next to roads. This treatment will help create and maintain

Figure 5- a visual of fuels thinning or precommercial thin. Ladder fuels are removed around the dominants and codominant. Early seral species are preferred for retention and competition is reduced.

strategic fuel breaks. Cutting may be accomplished by manual or mechanical (slash buster) methods. This prescription focuses on felling co-dominant or ladder fuels surrounding desirable overstory species. This helps decrease the risk of mortality from wildfire outside of its historical range. Slash may be treated through slash busting, hand-piling and burning which reduces the visual effects to the casual viewer, or is lopped up into small sections and scattered throughout the stand at an average height of 2’ above the ground to help with nutrient cycling. This prescription could be used in conjunction with a prescribed burn.

RHCA – HTH Riparian Thinning

The existing condition in riparian areas throughout the Sheep Creek Project area reflect historic management resulting in low resiliency to disturbance agents such as high severity wildfire and insect and disease mortality (Dwire et al. 2016). Thinning is proposed within RHCA’s to promote deficient broadleaf species (cottonwood, aspen and willow) and future large diameter trees. Objectives for this treatment are: 1. Restore resilient forest structure, 2. Maintain shade on existing streams, 3. Restore large diameter trees in riparian areas that lack large trees for future large woody debris recruitment, 4. Promote broadleaf species (cottonwood, alder and willow) where they exist and established broadleaf species. RHCA-HTH treatments are strategically place where existing roadbeds exist in the riparian habitat conservation area. Thinning would take place on uphill side of roads and equipment would be limited to staying on the road bed and reaching into a unit. Total suspension of removed material would be required when removing material. Thinning ladder fuels around drought and fire resilient species or broadleaf species, releasing residual trees and accelerating development of large tree structure. Riparian area stand density will be reduced contributing to strategic fuel break objectives. Maintaining shade on existing stream channels will be achieved by prohibiting removal of trees on the downhill side of road beds or within 50' of the center of stream channels, whichever is greatest.

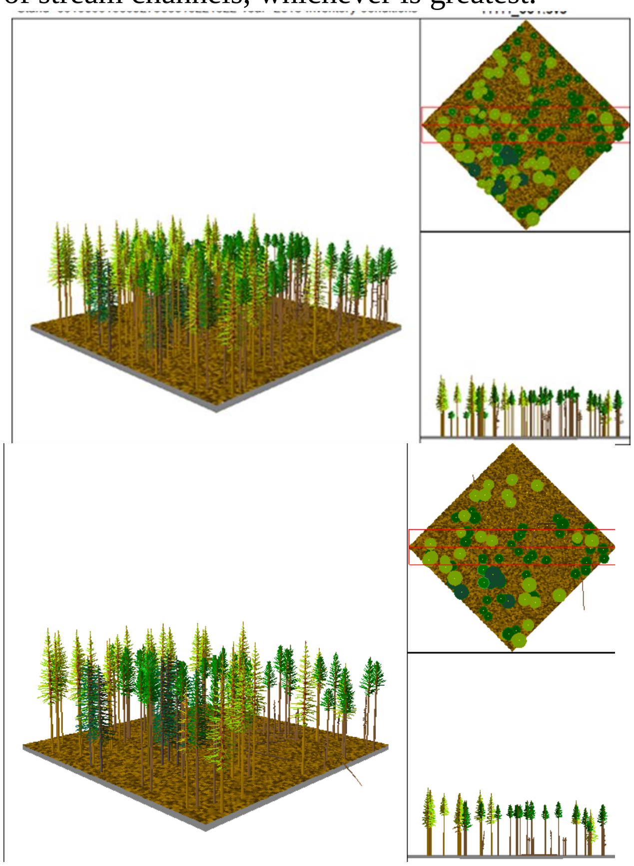


Figure 6-RHCA thinning- removes ladder fuels around early seral species, removed disease, suppressed or intermediate trees creating less competition for a codominant and dominant overstory.

RHCA-Wetland **(Riparian Habitat Conservation Area)**
The existing condition in riparian areas throughout the Sheep Creek Project area reflect historic management resulting in low resiliency to disturbance agents such as high severity wildfire and insect and disease mortality (Dwire et al. 2016). Cconifers that have encroached on a section of wet meadow along Sheep Creek (Unit 102). Once conifer invasions have begun, positive feedbacks can promote rapid conversion of meadow to forest (Halpern et al. 2010).

RCHA PDC - Riparian Habitat Conservation Area Project Design Criteria
Treatment would be limited to non-commercial hand thinning up to 9" DBH. This prescription prioritizes ladder fuel removal around early seral species or mid seral Douglas-fir, and reduces stand density to minimize intertree competition. This treatment follows the sideboards found in the Blue Mountain Project Design Criteria for hand thinning.

- Slash from thinning activities may be hand piled and burned with a maximum size of 4 feet in height and 6 feet in diameter following the guidelines below.
- Broadcast burning may occur using hand applied ignitions.
- No treatment buffers would occur directly adjacent to the stream channel following the guidelines described below.

The existing condition in riparian areas throughout the Sheep Creek Project area reflect historic management resulting in low resiliency to disturbance agents such as high severity wildfire and insect and disease mortality (Dwire et al. 2016). Maintaining these areas resiliency to disturbance is critical for providing habitat conditions suitable for fish and wildlife. Objectives for this treatment are:

1. Restore resilient forest structure with RHCA's
2. Maintain shade on existing streams
3. Restore large diameter trees in riparian areas that lack large trees for future large woody debris recruitment
4. Promote broadleaf species (cottonwood, alder and willow) where they exist and established broadleaf species.

Treatment will be limited to non-commercial, hand thinning removing trees up to 9 inches DBH. Thinning from below will target removing ladder fuels around existing early seral species or mid seral Douglas-fir, along with reducing overall stand density to a level where intertree completion is reduced. Disease trees will be targeted for removal, reducing trees predisposition to insect mortality (Powell 2014). Individual tree vigor, as determined by live crown ratio, disease presence and seral status, will dictate removal status, resulting in uneven spacing of residual trees. Slash resulting from thinning activities may be hand piled and burned with a maximum size of 4 feet in height and six feet in diameter following the guidelines below. Broadcast burning may occur using hand applied ignitions.
Treatment would be limited to the outer perimeter of RHCA. No treatment buffers will occur directly adjacent to the stream channel following the guidelines described below.

Table 1- Pacfish treatment guidelines following the Blue Mountain PDCs.

PACFISH/ INFISH Category	**Fish Bearing**	**Permanently Flowing non- fish Bearing and Ponds, Lakes and wetlands > 1 acres**	**Seasonally Flowing or Intermittent Streams, wetlands < 1 acres, landslides and landslide- prone areas**
Activity	**Default Limited Activity Buffers**		
Thinning in RHCAs	100'	75' on slopes < 30%	50' on slopes < 30%
	100'	75' on slopes < 30%	50' on slopes < 30%

Prescribed Fire in RHCAs			
Slash Pile Burning	100’	75’	50’

Effects Analysis

Alternatives considered:

Alternative 1: This alternative is the no action alternative and serves as the baseline for succession on its current trajectory.

Alternative 2: This alternative is designed to alter stand densities, structures, and composition to improve overall tree vigor and ability of trees to withstand forest pest, insects and drought. This alternative treat stands to improve fire resistance, improve tree vigor and growth, reduce completion and minimize losses to insect and disease. The proposed action was modified to reflect comments and concerns gathered during the scoping period as well.

Alternative 3: This alternative is designed to respond to comments from scoping. In general, all treatment units, commercial or non-commercial, inside moist or cold stands withdrawn from

Table 2- Proposed actions in the No Action Alternative, Alternative 2 and Alternative 3.

Alternative Elements		**No Action**	**Alternative 2**	**Alternative 3**
Total Harvest/Noncommercial Treatment Acres		**0**	**12,785**	**7,368**
Harvest Treatment Acres (total)			**3,367**	**1,308**
Ground Base Logging Systems		**0**	**2,662**	**1,243**
Skyline/ Advanced Logging Systems		**0**	**411**	**90**
Total Acres Treated by Prescription Type	HIM		280	100
	HIM – OFSS		490	332
	HIM – Biomass		39	33
	HTH		624	347
	HTH – OFSS		1,005	205
	HTH - Biomass		251	212
	HTH – UMZ		10	0
	HTH – RHCA		261	0
	HPO		235	43
	HPO – Biomass		41	29
	HSH		115	0
	HBT Enhance		16	7
Noncommercial Treatments			**9418**	**7,012**
Total Acres Treated by Prescription Type	FUH – Hand		2,416	2,012
	FUM – Mechanical		3,855	3,371

	PCT – Mechanical		989	424
	PCT – Hand		935	264
	RHCA – Wetland		36	36
	RHCA-PDC		1,118	875

Harvest Systems

Ground-base mechanized harvest equipment (whole tree skidding and cut-to-length systems (CTL)) is proposed for many of the commercial treated acres with continuous slopes less than 35%. This type of equipment will occur on 2,724 acres for Alternative 2 and 1,192 acres in alternative 3. CTL systems will be used for identified units with soil displacement concerns.

The cut-to-length approach is known to reduce soil disturbance normally associated with whole tree logging, due to the creation of common use trails, slash mats, the machine's ability to utilize existing road systems, and through reduced use of traditional landings. CTL approach is highly effective when in-the-woods harvesters are coupled with forwarders. While this would not be a requirement for this project, the equipment used must be able to fall, limb, and buck trees into logs at field location (i.e., at the stump) and logs must be fully suspended while being transported to decks.

The CTL system involves two main pieces of equipment, a harvester and a forwarder. The harvester operator is able to select trees from either side of the harvester and bring them to the front of it, where the limbs and tree tops are removed; these fall in front of the harvester and are called the slash mat. Then the harvester cuts logs to the desired length, sets them aside, and continues forward over the slash mat. The slash mat becomes the "forwarder trail." The forwarder follows behind the harvester and places the logs on a rack which suspends them off the ground instead of dragging them. The slash mat protects the soil from the equipment. The equipment compacts the slash as it moves over it.

Using ground-base mechanized equipment on slopes greater than 35% requires a Forest Plan amendment. Skyline and advanced logging systems will be utilized on units in the proposed action that have continuous slopes greater than 35%. This type of equipment will occur on 411 acres for Alternative 2 and 90 acres on alternative 3. The district proposes a project level plan amendment to the Wallowa-Whitman National Forest Land and Resource Management Plan (Forest Plan), to include ground-based equipment on slopes greater than 30% in select areas.

We developed this project level plan amendment in response to an issue raised during the scoping period. Advancements in logging technology have outpaced our Forest Plan updates and have become more accessible within our local economy. This amendment would allow us to closely monitor and understand the capabilities and limitations of tethered logging on our forest and aligns with purpose and need elements 5 (Economic Support) and 6 (Forest Partnerships). The La Grande IDT identified specific units that make good candidates based on economic feasibility (those originally proposed for skyline harvest) and low-risk soil types.

Forest Health and Sustainability

The following are analysis topics and corresponding indicator specific to the vegetation resource. These analysis topics will be tracked throughout the effects analysis to address whether, or to what degree, the project meets purpose and need objectives.

Table 10. Forest health and sustainability indicators and measures

Key Issue:	
Indicator	**Measure**
Old Forest	Acres of OFMS restored to OFSS
Other Issues	
Density	Acres restored to recommended stocking levels
Composition	Acres restored to HRV
Structure	Acres restored to HRV
Insect and Disease Susceptibility	Acres restored to HRV

Historical Range of Variation Guidance for Forest Vegetation Planning

District specialists assessed the historic range of variability (HRV) to compare the project area's current conditions against what ecologists believe existed during the pre-settlement era (Sheep Creek project file). When assessed at the watershed scale, HRV informs land managers about inherent variations in species composition, forest structure, and stand density to provide the framework for understanding the structure and behavior of contemporary ecosystems and is the basis for predicting future conditions (Powell, 2019). HRV is a tool that helps ensure management activities restore conditions under which native species, gene pools, communities, landscapes and ecosystem processes evolved. HRV represents a state of increased ecological resilience and adaptive capacities and is measured by forest structure, species composition, and density.

Forest Structure

The Oliver and Larson (1996) system has five classes of structural variation which include stand initiation, stem exclusion, understory reinitiation, old forest multi strata and old forest single strata (Powell 2019). Each type of forest structure supports wildlife habitat and ecological processes across all potential vegetation groups (PVGs).

Potential Vegetation Groups

Potential vegetation (PV) is defined as the community of plants that would become established if all successional sequences were completed without interference by humans. This implies that over the course of time, and in the absence of future disturbances, similar types of plant communities will develop on similar sites (Powell, 2019). PV is an aggregation of plant association groups (PAGs) with similar environmental regimes and dominant plant species. They indicate the rate vegetation changes on a site (Powell 2019).

Table 31. PVG Groups within the Sheep Creek Project area

PVG Groups within the Project area *(Upland Forest Only)*		
PVG	Acres	% of project area
Cold Upland Forest	14,192	49

Dry Upland Forest	8,214	28
Moist Upland Forest	6,155	21
Other	614	2
Total	29,175	100

Species Composition

Cover types are expressed as percentages of each PVG. Cover types may have a majority of one species (e.g., grand fir comprises more than 50% of trees in the stand, coded as grand fir) or if less than 50% of a species is dominant a cover type is named for the species existing at the highest percentage within the stand.

Tree Class Density

Disturbance processes regulate stand density by periodically killing trees and maintaining stocking levels within a range of variation that differs for each combination of species and plant association. Tree density is a characterization of tree stocking for an area. It expresses the number of tree stems occupying a unit of land. Stocking can be expressed as a “stand density index” or in some other measure of relative density, or it can be quantified in absolute terms as a number of trees per acre or as the amount of basal area, wood volume, or canopy cover on an area (Powell 1999).

Stand density index (SDI) helps managers predict forest health concerns, including, but not limited to, competition, fire hazard, insects and diseases (Cochran et al. 1994, Powell 1999). Published stocking guidelines (Powell, 1999) are used for evaluating stand density levels. Stand density is a characterization of tree stocking for an area. It expresses the number of stems occupying a unit of land. The following distinguish stands with different density levels:

- High stand density class: Stands at or above full stocking or normal density benchmark.
- Moderate stand density class: Stand within the lower and upper limits of a management zone where partial to full competition occurs, and inter-tree competition and mortality agents are less common.
- Low stand density class: Stands at or below the lower limits of the management zone.

Insect and Disease Susceptibility

Susceptibility is defined as a set of conditions that make a forest stand vulnerable to substantial injury from insects or diseases. Susceptibility assessments do not predict when insects or diseases might reach damaging levels; rather, they indicate whether stand conditions are conducive to declining forest health, as reflected by increasing levels of tree mortality from insect and disease organisms. To provide a process for evaluating insect and disease susceptibility, range of variation information was developed for different insect and disease agents, and three classes of susceptibility (high, moderate, low), and it is stratified by potential vegetation group (Powell 2019).

ALTERNATIVE 1- No Action

Summary: This alternative represents existing conditions within the project area and serves as the baseline for analysis of the two action alternatives. Alternative 1 would perpetuate a decline in overall forest health as described by stand density, composition and structure.

In the short term, distribution of forest cover type, forest structural stages and tree density class under alternative 1 would be expected to be like existing conditions (see forest structure, density and composition tables below). Alternative 1 does not meet the purpose and need of the project because there would be no restoration of structure, density and composition, thus no restoration of disturbance processes at the landscape scale. Disturbances will continue to increase in severity and potentially size depending on conditions (fire weather) under which they occur. The following is a discussion of change over time based on the current trajectory.

Direct and Indirect Effects

Tree Class Density

Tree density classes per species within each Plant Vegetation Group, are defined as follows:

- Low Tree Density – within the lower management zone
- Medium Tree Density – between the lower and upper management zones
- High Tree Density – near or above the upper management zones

Table 12. Stand Density Class HRV Analysis within the Sheep Creek Project Area for Dry, Cold and Moist Upland forest as expressed as percentages by potential vegetation group.

Stand Density Class (Expressed as basal area, in ft2/acre at 10" QMD)	Potential Vegetation Group Range of Variation (Percentage)			Current Conditions Range of Variation (Percentage)		
	Dry UF	Moist UF	Cold UF	Dry UF	Moist UF	Cold UF
Low (dry: <55; moist: <100; cold: <80)	40-85	20-40	15-35	30	48	28
Moderate (dry:55-85; moist:100-150; cold: 80-120)	15-30	25-60	20-40	34	22	24
High (dry:>85; moist: >150; cold: >120)	5-15	15-30	25-60	36	30	48

Notes: plant vegetation groups shaded in grey are within the range of variability. Low and moderate densities are within HRV for Moist and Cold Upland forest. High density stands are overrepresented in Dry and Moist Upland forest but are within HRV for Cold Forest.

Cold Upland Forests

Current stand densities are, in part, a result of past management. Under alternative one, 30% of this forest type would remain with high stocking densities and is within HRV (15-30%). 22% of this forest type would remain in moderate stand density class, below HRV 25-60%. Overstocked conditions would continue. Tree growth would continue to slow, and density related mortality will increase. These high and moderate stand density conditions prevent the regeneration requirements of early seral species, and as such, regeneration currently is dominated by late seral species such subalpine fir and Engelmann spruce. All trees, especially early seral species are experiencing intertree competition resulting in elevated moisture stress across stands and decreasing vigor of codominant and dominant trees (Cochran et.al 1994, Powell 1999). As stand density increases, the intensity of disturbance is likely to increase (Powell 2019). The no action alternative would leave roughly 72% of cold forest stands in the project area are at an elevated risk to high intensity disturbance, and as such, more area is expected to transition into lower density classes through time.

28% of cold forest would remain in the lower stand density class, which is also within the HRV (15-35%) and would be expected to experience ingrowth through time creating denser conditions. Cold forest stands in this lower density class are the result of past wildfire disturbance within the project area such as the Meadow and Boundary fire. These fires burnt at high intensities resulting in high mortality. These stands are recovering slowly due to a short growing season and harsh site conditions.

Moist Upland Forest

Under alternative one, 34% of this forest type would remain with high stocking densities which is above historic conditions (15-30%). Absence of fire has allowed thin-barked species, late seral species (grand fir, Engelmann spruce, and subalpine fir) to persist in these locations. These stands exhibit a two to multi-storied vertical structure where shade-tolerant late-seral and climax species often dominate. Horizontal structure varies from somewhat uniform to aggregated but commonly exceeds the lower limit of imminent competition mortality. If stands in this density class were to experience a disturbance, such as bark beetle outbreak or wildfire, existing vegetation may experience significant mortality which could reduce densities significantly.

44% of moist forest would remain in the medium stand density class which is within historical reference conditions (25-60%). Stands within this density class are fully stocked and do not create regeneration conditions conducive to promoting early seral species establishment. Nor do current stand densities favor retaining the vigor of existing early seral species (Cochran et al. 1994, Powell 1999). The no action alternative would leave roughly 78% of moist forest stands in the project area are at an elevated risk to high intensity disturbance, and as such, more area is expected to transition into lower density classes through time. Directional climate change will increase the intensity and frequency of disturbances to these sites jeopardizing sustainability of vegetation on the landscape (Johnston 2017).

Currently, 22% of this forest type would remain in the low stand density class and is within but on the low end of HRV (20-40%). This area would transition into a denser stand condition through time. Only areas in this density class may have existing conditions conducive for promoting the vigor of existing early seral species, however canopies may still be too dense to establish early seral species. Re-establishing early seral species and allowing them to gain a competitive advantage and achieve free-to-grow status, requires visible sky created through canopy openings (Jain et al. 2004).

Dry Upland Forest

Under alternative one, over 36% of this forest type would remain with high stocking densities which is over double the expected amount on the landscape when compared to HRV (5-15%). These forests historically had frequent fire disturbance to regulate the density class (Powell 2014). Douglas-fir and grand fir have encroached underneath existing overstory canopies creating ladder fuels that may transition wildfire from the ground to the canopy. These later seral species are not as drought or fire resilient as early seral species and are susceptible to competition induced mortality. Projected impacts from climate change indicate that this forest type will experience the longest period of water deficit (Powell 2014, Halofsky et al. 2017). This will greatly impact trees resources to defend themselves against pest, increasing the risk of insect outbreaks.

The moderate stand density class represents 34% of upland forest (HRV 15-30%), which is too dense to promote the vigor and establishment of early seral species, and the overstory canopy is experiencing competition induced mortality. The no action alternative would leave roughly 70% of dry forest stands in the project area are at an elevated risk to high intensity disturbance, and as such, more area is expected to transition into lower density classes through time.

Approximately 30 % of dry upland forest is in the low-density class which is below HRV (40-85%). This departure from HRV is largely attributed to past management in the project area. Stands in this density class experience the least amount of intertree competition and are expected to grow into denser stand classes through time.

Species Composition

Table 13. Vegetation Cover Type HRV Analysis for Moist Upland forest-current and desired species composition expressed as a percentage across the sheep creek landscape.

Vegetation Cover Type for Moist PVG	Range of variation for cover types (percentages)	Existing range of cover types (percentages)
Ponderosa Pine	5-15	< 1
Douglas-fir	15-30	4
Western Larch	10- 30	< 1
Lodgepole Pine	25-45	21
Grand Fir	15-30	73
Subalpine fir and spruce	1-10	2

Notes: Vegetation Cover Type HRV Analysis for Moist PVG. The gray shading indicates Vegetation Cover Types within HRV, lodgepole pine and subalpine fir and spruce. Early seral species and mid seral species (ponderosa pine, western larch, and Douglas-fir) are below. Equally significant, is the over representation of the Grand Fir Cover Type. Grand fir encroachment can attribute to fire suppression. Regeneration harvest in the 70's and 80's within Moist PVG regenerated with lodgepole pine due to cold temperatures.

Table 14. Vegetation Cover Type HRV Analysis for Dry Upland forest- current and desired species composition expressed as a percentage across the sheep creek landscape.

Vegetation Cover Type for Dry PVG	Range of variation for cover types (percentages)	Existing range of cover types (percentages)
Ponderosa Pine	50-80	2
Douglas-fir	5-20	16
Western Larch	1-10	<1
Lodgepole Pine	0	11
Grand Fir	1-10	71
Subalpine fir and spruce	0	<1

Notes: The gray shading indicates Vegetation Cover Types within HRV, Douglas-fir and subalpine fir and spruce. Early seral species Cover Types (ponderosa pine, western larch) are below HRV and late-seral Grand Fir and lodgepole pine Cover Type are overrepresented. Grand fir encroachment can attribute to fire suppression. Regeneration harvest in the 70's and 80's within Dry PVG regenerated with lodgepole pine due to cold temperatures.

Table 15. Vegetation Cover Type HRV Analysis for Cold Upland forest current and desired species composition expressed as a percentage across the sheep creek landscape.

Vegetation Cover Type for Cold PVG	Range of variation for cover types (%)	Existing range of cover types (%)
Ponderosa Pine	0-5	<1

Douglas-fir	5-15	<1
Western Larch	5- 15	<1
Lodgepole Pine	25-45	46
Grand Fir	5-15	38
Subalpine fir and spruce	15-35	16

Notes:The gray shading indicates Vegetation Cover Types within HRV, Douglas-fir and subalpine fir and spruce. Early seral species Cover Types (ponderosa pine, western larch) are below HRV and late-seral Grand Fir and lodgepole pine Cover Type are overrepresented. Regeneration harvest in the 70's and 80's within Dry PVG regenerated with lodgepole pine due to cold temperatures. Grand fir encroachment can be attributed to fire suppression.

Results from the Cover Type HRV Analysis are consistent with the management history of the Sheep Creek project area. Across Moist and Dry Upland Forest late seral (shade tolerant) and fire intolerant species (e.g. Grand Fir) are overrepresented across the landscape. Conditions would continue to favor Douglas-fir and grand fir. Seral species (ponderosa pine and western larch) would continue to stagnant and decline moving farther outside RV.

Moist Upland Forest

Moist Upland Forest contains a mix of species and size classes, many exhibiting a two to multi-storied vertical structure where shade-tolerant late-seral and climax species often dominate. Late seral species cover (grand fir, subalpine fir and Engelmann spruce) is overrepresented, occurring across roughly 75% of the PVG (HRV 16-40%). These sites have the most water availability of all upland forest, and because of this, these forests have undergone the greatest magnitude of vegetation change over the last 150 years (Johnson 2017). These mid-to-late successional layer types are at greater susceptibility to two defoliators, Douglas-fir tussock moth and spruce budworm. These defoliators can increase to outbreak levels and cause substantial damage to host species across the landscape and have done so in or within the vicinity of the project area from 1954-1957 and 1981-1991 (ADS 1947-present). In part, this is because host trees are a major component of the stands in contrast to early successional layer types dominated by non-hosts or a mix of host and nonhost species (Clausnitzer 1993). Although these two defoliators were not observed at the time of our reconnaissance, they present a risk to this forest type.

With the no action alternative, existing early seral species that are contributing to species diversity would continue to lose dominance to shade tolerant species in partial shade (Johnson 2017, Powell 2014). Currently early seral species dominate less than 2% of the project area in moist forest, which is severely underrepresented compared to HRV (15-45%). Dwarf mistletoe infections are severe in western larch in some locations, decreasing larch's vigor even further predisposing it to mortality (Hawksworth and Wens 1996).

Dry Upland Forest

Historically large diameter and old ponderosa pine, and to a lesser extent western larch and Douglas- fir, occupy these sites. Due to fire suppression, Douglas-fir and grand fir have encroached into portions of sites with greater water supply capacity and are overrepresented dry upland forest, covering 83% of this forest type compared to HRV (6-30%). Early seral cover type currently represents 3% of the dry forest in this project area and is significantly below HRV (51-90%). Lodgepole pine cover exists primarily from past regeneration harvests occurring in the 1970-early 90's and was the most successful at regenerating naturally, possibly due to cold temperatures. As such it covers 11% of the Dry Upland forest type and is overrepresented when compared to HRV (0%).

With the no action alternative and directional climate change into hotter drier periods, this upland forest type is at risk to substantial mortality from insect outbreaks and fire. Early seral species will continue to lose dominance to shade tolerant species in partial shade (Johnson 2017, Powell

2014). Furthermore, Dwarf mistletoe infections are severe in Douglas- fir in some locations, decreasing vigor and predisposing it to mortality (Hawksworth and Wens 1996).

Cold Upland Forests

These forests contain a mix of species and size classes, many exhibiting a two or more storied vertical structure where shade-tolerant late-seral and climax species dominate. Wildfire and timber harvest removed overstory canopy and regenerated naturally with lodgepole pine cover. Fire suppression has allowed late seral climax species to persist and encroach on early seral species. With the no action alternative, lodgepole pine and late seral species (grand fir and subalpine fir/Engelmann spruce) would continue to be over-represented across the landscape while early seral species would be largely under-represented and continue to decrease (Johnson 2017). Currently early seral species cover is below HRV covering less than 2% of moist upland forest (HRV 10-35%). Both late seral species and lodgepole pine vegetation cover types are overrepresented in the project area compared to HRV. Late seral species covers 54% of this forest type (HRV 20-50%) and lodgepole pine covers 46% (HRV 25-45%).

The current percentage of subalpine fir is below HRV. Many of the remaining subalpine fir exhibit severe infestations and damage from balsam woolly adelgid. Lodgepole pine stands characteristically develop outbreaks of Mountain Pine beetle and are sustained in stands greater than 80 years old, with an average tree diameter greater than 8 inches DBH, over 100 sq. ft. of basal area per acre and generally between 300-600 trees per acre (Gibson et al. 2009). Roughly 48% of the cold forest that has lodgepole pine cover is at risk to Mountain Pine beetle mortality.

Forest Structure

Early logging on forest service lands was focused on removal of commercially valuable stands of old ponderosa pine (Powell 2014). As the drought and shade intolerant ponderosa pine was harvested, it was replaced in many areas by less drought tolerant species that are more shade tolerant, such as grand fir and Douglas-fir. The more open, single-storied ponderosa pine stands converted to multi-storied stands. As stand densities increased and species compositions and forest structures were altered, the frequency and intensity of insect outbreaks increased.

Table 16. Present and historical conditions of forest vegetation types in Sheep and Chicken Creek watersheds (HUC 12)

PVG	Existing Acres	% of PVG	Historical Range %
Old Forest Multi Stratum (OFMS)			
moist upland	1191	19%	15-20%
dry upland	1119	14%	1-15%
cold upland	2422	17%	10-25%
Old Forest Single Stratum (OFSS)			
moist upland	0	0%	10-20%
dry upland	0	0%	40-65%
cold upland	1	<1%	5-20%
Understory Reinitiation (UR)			
moist upland	2755	45%	15-25%
dry upland	4085	50%	0-5%
cold upland	8106	57%	10-25%
Stem Exclusion (SE)			
moist upland	1,941	32%	20-30%

dry upland	2727	33%	10-20%
cold upland	3233	23%	15-30%
Stand Initiation (SI)			
moist upland	268	4%	20-30%
dry upland	283	3%	15-30%
cold upland	431	3%	20-45%

OFMS

Many age classes and vegetation layers compose this structural stage containing large and old trees. Snags and decayed fallen trees may also be present, leaving a discontinuous overstory canopy. Old forest multi strata (OFMS) forest structure is within HRV for all PVGs. Moist Upland Forest is at 19% of the area (HRV 15-20%), Dry Upland Forest is at 14% of the area (HRV 1-15%) and Cold upland forest is at 17% of the area (HRV 10-25%). In general, for all plant vegetation groups within the project area, there is an expected amount of late and old multi-strata structure across the landscape. Directional climate change is expected to bring more frequent and intense disturbances in the future to these forests, rendering their current condition a high risk for mortality.

OFSS

Old forest single strata (OFSS) structure is deficient across the landscape. This structure type is below HRV for all PVG's; moist upland forest covers 1% of the area (HRV 10-20%), dry upland forest covers less than 1% of the area (HRV 40-65%), cold upland forest covers less than 1% of the area (HRV 5-20%). One consequence of fire exclusion is an extensive deficiency across the landscape. OFSS forest structure is dependent on frequent low intensity fire disturbance. Since fire has not entered most of the project area in the last 100 years, there has been no mechanism to create or maintain this structure. Past harvest has also contributed to this loss of structure with old harvest removing most of the late and old individuals from the stand.

UR, SE and SI

In the absence of disturbances, the no action alternative successional pathways from stand initiation to old forest would continue. Tree growth would slow in areas of high stocking. Forest structure would continue to be outside of HRV and favor multi-storied conditions.

Understory reinitiation forest structural stage is overrepresented across all PVGs; moist upland forest covers 1% of the area (HRV 10-20%), dry upland forest covers 50% of the area (HRV 0-5%), cold upland forest covers 57% of the area (HRV 15-25%). Lack of fire disturbance has allowed forest stands to develop closed canopies, transforming vertical forest structure from one high canopy layer to multiple canopy layers in the understory and has been allowed to persist. This arrangement creates ladder fuels that increase the probability for ground fire to transition into crown fire (Powell 2019). As such, if fire was introduced into these stands, they risk high mortality.

Stem exclusion is overrepresented across dry upland forest (33%, HRV 10-20%) and moist (32%, HRV 20-30%), and within HRV for cold (23%, HRV 15-30%). Many of these stands originated from previous harvest activities, regenerated naturally, and have grown without intervention. These stands currently experience intertree competition decreasing the overall vigor of trees, and inherently increases their susceptibility to disturbance agents. Past management has left undesirable species dominating the composition of the stand.

Stand initiation (SI) is below HRV across all PVGs. SI is created and maintained by disturbance agents such as insects, disease and severe wildfire (Powell 2019). Regeneration harvest may also create this structure type, however minimal amount of timber harvest has occurred in the project areas since the mid 1990's (see specialist report). Climate change is expected to increase the area effected by severe fire and extensive outbreaks of insects and diseases (Halofsky & Peterson 2017). These disturbances may create large areas of SI conditions very quickly, as was realized in the firestorm that swept across western Oregon in September 2020 (Urness 2020).

Insect and Disease Susceptibility

Table 14. Range of variation information for insect and disease susceptibility, expressed as percentages by agent and potential vegetation group.

Plant Vegetation Group	Insect and Disease Agents	Susceptibility Rating- % of Forest Area					
		Low		moderate		High	
		Existing	RV Range	Existing	RV Range	Existing	RV Range
Cold Upland forest (UF)	Defoliators	28%	40-95 ↓	24%	15-25	48%	5-10 ↑
	Douglas-fir Beetle		45-95 ↓		10-25		5-10 ↑
	Fir Engraver		35-75 ↓		20-45		5-10 ↑
	Bark Beetles in P Pine		55-95 ↓		5-30		0-5 ↑
	Mistletoes		50-100 ↓		40-80 ↓		30-70
	Root Disease		30-65↓		20-45		10-15 ↑
Moist Upland forest (UF)	Defoliators	48%	5-20 ↓	22%	20-30 ↑	30%	35-80 ↓
	Douglas-fir Beetle		30-60 ↓		20-40 ↑		10-30↑
	Fir Engraver		30-70 ↓		10-20 ↑		20-40
	Bark Beetles in P Pine		30-65 ↓		15-30 ↑		15-35
	Mistletoes		85-100 ↓		35-85		50-90 ↓
	Root Disease		5-25		20-40 ↑		35-65
Dry Upland forest (UF)	Defoliators	30%	40-85 ↓	34%	15-30 ↑	36%	5-15 ↑
	Douglas-fir Beetle		35-75 ↓		15-30 ↑		10-25↑
	Fir Engraver		45-95 ↓		10-25 ↑		5-10 ↑
	Bark Beetles in P Pine		35-75 ↓		15-35		10-20 ↑
	Mistletoes		85-100 ↓		15-65		20-35 ↑
	Root Disease		35-75 ↓		20-35		5-20 ↑

↓ less than RV; ↑ greater than RV

High, Moderate and Low Susceptibility Ratings

Current composition, structure, and stand density across all upland forest reflects that the project area has excessive amount of dense, multi-layered canopy stands, with a high proportion of host tree species, and face greater competition for soil moisture and nutrients. This increases upland forest insect or disease susceptibility. To provide a process for evaluating insect and disease susceptibility, range of variation information was developed for insect and disease agents, and three classes of susceptibility (high, moderate, low); it is stratified by potential vegetation group (Powell 2019). There is an excessive amount (above HRV) of the project area, throughout all upland forest types, that is highly susceptible or moderately susceptible to defoliators, beetles, mistletoe and root disease. In turn, there is a deficiency across all PVG's for stands that exhibit high resilience and resistant characteristics (low susceptibility rating) to these disturbance agents.

Characteristic levels of insect and disease activity consistent with the range of variability would contribute to diverse landscape conditions and provide important wildlife habitat components. The no action alternative would leave 72 % of cold upland forest, 52% of moist upland forest and 70% of dry upland forest within the project area at an elevated risk to disturbance agents. These conditions indicate that a large percentage of the project area is at risk to high levels of mortality.

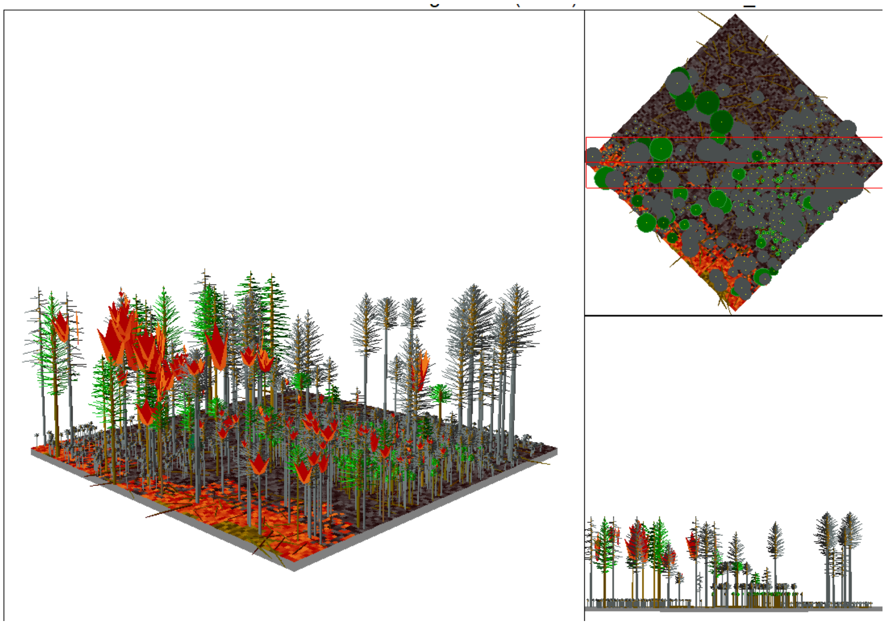


Figure 7- Depicts a plausible scenario if an ignition source occurred within the project area on a typical summer day (75 degrees Fahrenheit with moderate winds up to 20 miles per hour). The result- high severity crown fire. Disturbances like wildfire or insect mortality could drastically change current conditions such as density, species composition and forest structure across all forest vegetation groups. These disturbances occur naturally on the landscape and are expected in this project area, however due to past management the current conditions of these stands exhibit low resiliency to these disturbances.

Alternative 2

Summary: The Forest Service proposes to implement activities across approximately 11,760 acres in the Sheep Creek Project Area to meet the purpose and need. Silviculture treatments would provide a diversity of forest structures that are more in line with desired conditions, and more resilient to anticipated future environmental conditions. Forest thinning prescriptions would follow a practical, science-based approach intended to restore characteristic functionality, resistance and resilience to disturbance. These are conditions which have developed over the long term (Powell 2019).

Thinning and mechanical fuel treatments would encourage the development of large tree structural characteristics, understory plant diversity, forage productivity, and resilience to disturbances such as wildfire. Thinning younger trees across areas that are recovering from a stand replacement disturbance may encourage the development of spatial heterogeneity and increase the proportion of early seral tree species. Silvicultural treatments would generally retain and protect large trees of early seral species and trees with old growth physical characteristics consistent with historical reference conditions. All action alternatives would aim to foster the re-introduction of planned and unplanned fire where it would be ecologically beneficial.

In places where legacies of historic forest patterns are absent (e.g., young, post-fire or regenerated harvest forest areas), information is used from neighboring similar habitats to recreate historical forest patterns by developing spatial heterogeneity and increase the proportion of early seral species. Thinning, and mechanical fuel treatments would encourage the development of large tree structural characteristics, understory plant diversity, forage productivity, and resilience to disturbances such as wildfire.

Regeneration of openings that result from the thinning and regeneration openings harvest (HPO, HIM and HSH treatments) would rely on natural regeneration of conifer species or may require planting (including white pine blister rust resistant stock) to ensure the prescribed post treatment stocking and species mix is attained. Prescribed burning would reduce fuel loads, increase understory productivity and diversity, allow fire to perform its natural ecological role, and reduce uncharacteristic disturbance from wildfire, insects, and disease. All action alternatives would aim to foster the re-introduction of planned and unplanned fire where it would be ecologically beneficial.

To restore insect and disease-related disturbance regimes in the project area, and move toward desired conditions, forest densities and species composition must be strategically restored in appropriate locations. Tools available to reduce uncharacteristic insect and disease disturbance include thinning toward more natural forest structures, and the legally, ecologically, and socially appropriate use of planned and unplanned fire.

Tree Class Density

Treated areas would hold density classes for a period of 15-20 years or longer depending on site potential and climate.

Overall, alternative 2 would move or maintain all density classes within or closer to the HRV for each PVG. Alternative 2 adopts the approach to sometimes create more area in lower stand density classes than what was historically expected to address:

- Current estimations of stand density commonly exceed the lower limit of the self-thinning zone resulting in elevated moisture stress induced by competition.
- Existing vegetation has suffered additional moisture stress induced by protracted drought in recent years.
- Competition and drought induced moisture stress have predisposed grand fir and lodgepole pine to elevated risk of mortality caused by fir engraver, Scolytus ventralis, and mountain pine beetle, Dendroctonus ponderosae, respectively.
- Greater duration of water deficit and greater extremes in both temperature and precipitation during the period of water deficit are expected in the coming decades. Consequently, water supply capacity of these sites is expected to diminish further.
- Reducing current moisture demand to a level consistent with the water supply capacity of the site will help to mitigate competition induced moisture stress, moisture stress caused by infrequent periods of drought and predicted climatic conditions for the coming decades.
- Spacings leaves trees to at least the lower limit of full site occupancy (Long,1985) and

maintaining stand density below the zone of imminent competition mortality (Long 1985) will improve vigor of the leave trees and promote resilience and resistance to mortality agents and defoliators.

- Johnson (2016) shows that more productive forest stands (generally moist sites) experience greater relative change than dry forest with moisture availability and lack of disturbance (fire). Having more area in low or moderate stand density class may benefit the landscape resiliency.

Table 15. Historical, current, and alternative conditions of stand density class in Sheep and Chicken Creek watersheds (HUC 12) for Dry, Cold and Moist Upland forest as expressed as percentages by potential vegetation group.

Stand Density Class (Expressed as basal area, in ft2/acre at 10" QMD)	Potential Vegetation Group Range of Variation (Percentage)			Current Conditions Range of Variation (Percentage)						Alt 2						Alt 3					
				Dry UF		Moist UF		Cold UF		Dry UF		Moist UF		Cold UF		Dry UF		Moist UF		Cold UF	
	Dry	Moist	Cold	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Low (dry: <55; moist: <100; cold: <80)	40-85	20-40	15-35	2475	30	2961	48	3985	28	3792	46	3810	62	5224	37	3289	40	3179	52	4286	30
Moderate (dry:55-85; moist:100-150; cold: 80-120)	15-30	25-60	20-40	2768	34	1343	22	3356	24	2792	34	998	16	4319	30	2815	34	1430	23	3988	28
High (dry:>85; moist: >150; cold: >120)	1-15	15-30	25-60	2971	36	1851	30	6851	48	1630	20	1347	22	4649	33	2110	26	1546	25	5918	42

Cold Upland Forest

High Density: Alternative 2 would reduce 2,202 acres of high density Cold Upland Forest into moderate or low-density classes, resulting in 33% (4,649 acres) of cold forest in high density classes. This reduction of area still maintains high density class area within the HRV 25-60%. Existing vegetation in this density class has suffered additional moisture stress induced by protracted drought in recent years, predisposing host species such as lodgepole pine to elevated risk of mortality caused by mountain pine beetle, *Dendroctonus ponderosae*.

Moderate Density: Treatment will maintain area within the moderate stand density class or reduce into the low-density class, resulting in 30% of cold forest (3,988 acres) and is within HRV (20-40%).

Low Density: Low density cold forest area is maintained or expected to increase via treatment that reduces high and moderate stand densities into the low-density class. Currently, 28% of the total area (3,985 acres) is within low density class and alternative 2 will increase this area to 37% (5224), HRV 15-35%). Having slightly more area in lower density class will help address more frequent and intense disturbances that are expected with climate change (Halofsky and Peterson 2017).

Moist Upland Forest

High Density: Alternative 2 would reduce 504 acres of high density Moist Upland Forest into moderate or low-density classes, resulting in 22% (1,347 acres and is within HRV (15-30%).

Moderate Density: Treatment will maintain area within the moderate stand density class or reduce into the low-density class, resulting in 16% (988 acres) and is below HRV (20-40%).

Low Density: Alternative 2 increases low density moist forest from 48% of the total area (2,961 acres) to 62% of the area (3,810 acres). Johnson (2016) explains that moister and more productive forest stands have experienced greater relative change compared to dry upland forest, due to moisture availability and lack of disturbance (fire). Furthermore, directional climate change will likely impose moisture constraints historically experienced by drier sites on cold and moist upland forest. These principals argue to create/ maintain larger areas within low to moderate stand density class to build resiliency to future disturbances.

Dry Upland Forest

High Density: Alternative 2 would reduce 1,341 acres within high density class to the moderate or low-density classes. This results in 20% (1,630 acres) of dry forest in high density classes for Alternative 2 and remains well over HRV (1-15%). This area is at the highest risk to disturbance agents and high intensity fire. Follow up treatment such as additional harvest entries or prescribe fire will be necessary to help reduce this area to the desired level.

Moderate Density: Currently there is 2768 acres or 34% of the area within the moderate stand density class. Alternative 2 treatments would result in 34 % (2,792 acres) and exceed HRV (15-30%). Without treatment this area would grow into the high-density class in the next 10-20 years, expanding the overly abundant amount of area in high density class above HRV.

Low Density: Alternative 2 reduces acres within the high and moderate stand density classes to the low-density class, resulting in 46% (3,792 acres) of low density stands within the project area. Both alternatives would increase acres of low stand density class within HRV (40-85%). These stands are more resilient to disturbance agents because intertree competition is not occurring within the stand, promoting individual tree vigor, and increasing a trees ability to defend itself against disturbance agents.

Composition

In general, alternative 2 would maintain disease free existing early seral species where they exist in each upland forest type and create condition conducive to early seral species establishment where they are currently lacking. Alternative 2 adopts the approach to create more area with early seral species than what was historically expected to help restore resilience. Restoring species composition towards HRV can at times require removing larger, but younger (less than 150 years old) shade-tolerant species to favor shade-intolerant species. Post-harvest prescribed burning of these stands would play an important role in maintaining them.

- Favoring a mix of nonhost species or nonhost and host species and maintaining even aged or single-story structures will reduce risk to defoliators.
- Favoring species employing a fire resister adaptation to frequent low to moderate fire intensity will further reduce risk to mortality agents under the climate conditions expected in the coming decades.

Table 19. Historical, current, and alternative conditions of cover types in Sheep and Chicken Creek watersheds (HUC 12) for Dry, Cold and Moist Upland forest as expressed as percentages by potential vegetation group.

PVG	Cover Type	HRV %	No Action Pre-Implementation Acres	No Action Pre-Implementation %	Alternative 2 Post Acres	Alternative 2 Post %	Alternative 3 Post Acres	Alternative 3 Post %
Moist PVG	Grand Fir, Subalpine Fir and Engelmann Spruce	(15-30%,1-10%) **16-40%**	4,672	75	2,065	33	3,572	57
	Lodgepole Pine	25-45%	1,308	21	864	14	1056	17
	Western Larch, Ponderosa Pine, Douglas-Fir	(10-30%, 5-15%, 15-30%) **30%-75%**	237	4	3,287	53	1,589	26
Dry PVG	Grand Fir, Subalpine Fir and Engelmann Spruce	(1-10%, 0%) **1-10%**	6,818	83	4028	49	4508	55
	Lodgepole Pine	0%	36	<1	0	0	0	0
	Western Larch, Ponderosa Pine, Douglas-Fir	(1-10%, 50-80%, 5-20%) **56%-100%**	1360	17	4187	51	3707	45
Cold PVG	Grand Fir, Subalpine Fir and Engelmann Spruce	(5-15% 15-35%) **20-50%**	7,599	54	5825	33	6053	43
	Lodgepole Pine	25-45%	6,593	46	3665	26	5108	36
	Western Larch, Ponderosa Pine, Douglas-Fir	(5-15%, 5-15%, 0-5%) **10-35%**	<1	<1	5825	41	3031	21

Cold Upland Forest

Alternative 2 would treat 1,774 acres of late seral dominant stands and 2,928 acres of lodgepole dominant stands to promote deficient early seral species that exist within cold upland forest. Treatments would result in 33% (5,825 acres) of the area in late seral species cover type (within HRV 20-50%), and 26% (3,665 acres) of the area in lodgepole pine cover type (within HRV 25-45%), and 41% (5,825 acres) of the area in early seral species (over HRV 10-35%). Climate change is expected to diminish the water supply capacity of this upland forest type along with Moist upland forest; favoring early seral species will make these forest types less susceptible to uncharacteristic wildfire and lower the risk from uncharacteristic insect and disease infestations and epidemics (Powell 2014; Johnston 2017).

Moist Upland Forest

Alternative 2 converts 2,607 acres of late seral cover type and 444 acres of lodgepole pine cover type into early seral cover type; reducing late seral species cover to 33% (2,065 acres) of moist upland forest (within HRV 16-40%). Lodgepole pine cover types would be reduced to 14% (864 acres) of moist forest (below HRV 25-45%). This would result in 53% (3,287 acres) of the area with early seral cover (within HRV 30-75%). Lodgepole pine is a short-lived species (Powell, 2014) and is less resilient to disturbances such as fire or drought than ponderosa pine or western larch. These early seral species are long lived and can regenerate and persist in patches (Schaedel et al. 2017, Johnson 2017). Moving stands below HRV in lodgepole cover type to increase early seral HRV would help build stand resilience. Post-harvest prescribed burning of these stands would play an important role in early seral maintenance.

Dry Upland Forest

Alternative 2 would convert 2,790 acres from late seral species cover type and 36 acres of the lodgepole cover types to establish and maintain the early seral species that exist within the PVG. Treatments would reduce late seral cover to 49% (4,028 acres) which is still over HRV 1-10%, and 0% of the area in lodgepole pine cover type (within HRV 0%). Early seral cover type would increase to 51 % (4,187 acres) of dry forest in the project area (under HRV 56-100%). Management area restrictions, wildlife protection and terrain limit the amount of dry upland forest that can be restored into the desired condition containing early seral species.

Structure

Table 20. Historical, current, and alternative conditions of forest structures in Sheep and Chicken Creek watersheds (HUC 12) for Dry, Cold and Moist Upland forest as expressed as percentages by potential vegetation group.

Present and historical conditions of forest vegetation types in Sheep and Chicken Creek watersheds (HUC 12)							
	HRV	Current Conditions		Alt 2		Alt 3	
PVG	Historical Range %	Existing Acres	% of PVG	Existing Acres	% of PVG	Existing Acres	% of PVG
Old Forest Multi Stratum (OFMS)							
moist upland	15-20%	1191	19%	1046	17	1191	19
dry upland	1-15%	1119	14%	830	10	1119	14
cold upland	10-25%	2422	17%	2222	16	2422	17
Old Forest Single Stratum (OFSS)							
moist upland	10-20%	0	0%	145	2	0	0
dry upland	40-65%	0	0%	289	4	0	0
cold upland	5-20%	1	<1%	200	1	1	0
Understory Reinitiation (UR)							
moist upland	15-25%	2755	45%	3547	58	3065	49

dry upland	0-5%	4085	50%	4901	60	4974	61
cold upland	10-25%	8106	57%	9710	68	9164	65
Stem Exclusion (SE)							
moist upland	20-30%	1,941	32%	1031	17	1602	26
dry upland	10-20%	2727	33%	1833	22	1833	22
cold upland	15-30%	3233	23%	1464	10	2226	16
Stand Initiation (SI)							
moist upland	20-30%	268	4%	386	6	297	5
dry upland	15-30%	283	3%	361	4	288	4
cold upland	20-45%	431	3%	597	4	380	3

Old Forest Multi-Strata

OFSS is severely deficient or nonexistent across the landscape and is concerning because this structure type is the most resilient to fire disturbance regimes typical for ponderosa pine dominated stands; which climate change is predicted to also impose similar regimes for dry and mixed conifer stands (Johnson 2017, Halofsky & Peterson 2017). The most direct method is to convert OFMS stands to OFSS by removing the suppressed, intermediate, and some co-dominant trees. This maintains late and old structure in the overstory and removes potential ladder fuels that threatens moving fire from the ground level into the canopy. Alternative 2 uses this strategy and reduces 634 acres of OFMS stands for direct conversion to OFSS stands in upland forest across the planning area.

- Cold: OFMS would be reduced by 1% (200 acres) for a total of 16% cold OFMS (within HRV 10-25%)
- Moist: OFMS would be reduced by 2% (145 acres) for a total of 17% moist OFMS (within HRV 15-20%)
- Dry: OFMS would be reduced by 4% (289 acres) for a total of 10% dry OFMS (within HRV 1-15%).

Maintaining functioning OFMS stands across all upland forest types is important for maintain quality habitat for a variety of wildlife species (Franklin et al. 2013a) and is why alternative 2 does not convert more OFMS into OFSS.

Old Forest Single-Strata

Thinning stands currently in the understory re-initiation (UR) or stem exclusion (SE) forest structure stage reduces competition and accelerates diameter growth of residual trees. This would decrease the amount of time it takes for a stand to develop into late and old structure (Cochran & Seidel 1999; Cochran & Dahms 1998; Powell 2014). A selected number of stands currently in the UR structure stage will likely grow (acquire the minimum number of trees > 21" diameter at breast height to meet interim Region 6 old growth definition) into late and old structure in the next 10-20 years after treatment are with and OFSS objective (HTH-OFSS, HIM-OFSS).

Alternative 2 treats 893 acres of upland forest of these described stands in the UR structure stage- 459 acres occurring in dry, 156 acres occurring in moist and 277 acres occurring in cold. After treatment prescribe fire would play and monumental role in maintaining the OFSS structure. For conceptual purposes, after allowing these stands to develop into OFSS structure which would occur in the next 10-20 years, assuming these stands would not experience any disturbance that would change the structure development trajectory, Alternative 2 would develop or convert 1526 acres into OFSS. Dry Upland Forest would then contain 748 acres or 9% its total area (HRV 40-65%), Moist Upland Forest would contain 301 acres or 5% of its total area (HRV 10-20%), and Cold Upland Forest would contain 477 acres or 3% of its total area (HRV 5-20%).

The projected outcome of alternative 2 illustrates the time commitment necessary to develop late and old structure within the project area. Although treatment included in alternative 2 is a necessary step towards achieving our desired condition, post-harvest prescribed burning and additional treatment entries of these stands is critical in maintaining and developing more area into OFSS.

Understory Reinitiation and Stem Exclusion

Understory re-initiation forest structure stage across all PVGs is overrepresented (above HRV) across all PVGs. Stem exclusion is overrepresented across Dry and Moist Upland Forest, and within HRV for Cold Upland Forest. This is largely a consequence of the past timber harvest, fire suppression and grazing. Alternative 2 will largely focus on developing UR and SE stands towards late and old structure. Commercial and noncommercial treatment in stands that are in the UR structure stage lack a large diameter tree component, require periodic (roughly every 20 years) prescribe fire, and additional treatment entries to maintain development into OFSS.

Stands in SE structure stage that are proposed for treatment, would convert to UR, because thinning reduces intertree competition that currently is prohibiting the establishment of an understory age class. Openings, resulting from treatments, may be colonized in the next 10-20 years to create an understory age class. For this reason, the proposed stands to be treated currently in the SE structural stage will shift into UR. Alternative 2 treats 9696 acres in the UR or SE forest structural stage, 1465 acres commercially and 8231 acres noncommercially, across all PVGs.

Stand Initiation

Stand initiation (SI) forest structure is below HRV across all PVGs. This is largely attributed to a lack of any regeneration timber harvest, none of which has occurred since the mid 1990's and fire suppression. Disturbance agents such as insects, disease and severe wildfire are key contributors for creating and maintaining SI (Powell 2019) and were observed across the planning area. Climate change is expected to increase the area effected by severe fire and extensive outbreaks of insects and diseases in the coming decades (Halofsky & Peterson 2017). These disturbances may create large areas of SI conditions very quickly, as was realized in the firestorm that swept across western Oregon in September 2020 (Urness 2020). Knowing that past management has altered current conditions of the project area into a non-resilient state against high intensity/ mortality disturbances, presents a foreseeable risk that a disturbance could enter the project area and drastically move an abundance of the upland forest area into the stand initiation structural type (Halofsky & Peterson 2017). Considering how directional climate change is projecting more frequent and intense disturbances, the approach that does not actively seek to create stand initiation structural stage unless there is a warranted reason such as disease presence or the presence of vigorous disease-free larch in Cold or moist upland forest (Johnson 2017).

Utilizing this approach, Alternative 2 HPO, HBT ENHANCE and HSH treatments would create a total of 361 acres in the SI structural stage with 78 acres in Dry, 118 acres in Moist and 166 acres in Cold Upland Forest. This alternative does not substantially move any PVG towards HRV in terms of area within the SI forest structure. These treatments jump on opportunities to enhance regeneration of early seral species and address root disease.

Alternative 3

Summary: The proposed vegetation treatments in Alternative 3 would be expected to have the same effect as alternative 2. The deferral of 4,465 treatment acres in cold and moist upland forest treatments as well as late and old forest (OFMS) would reduce the resilience and resistance to mortality agents and defoliators along with resiliency against fire in those forest.

Tree Class Density

Alternative 3 leaves more a forest area then alternative 2 in its current condition which has low resiliency and is not at, nor likely to reach the landscape desired conditions.

Cold Upland Forest

High density Class: Alternative 3 would move 993 acres of high-density cold forest into moderate or low-density classes. This would result with 42% (5,918 acres) of the area remaining in the high-density class and is within HRV (25-60). In this density class, this forest type is at risk to high levels of mortality within the stand due to the amount of competition occurring. Furthermore, density levels are not conducive to regenerating early seral species.

Moderate density Class: Alternative 3 would maintain stands in the moderate density class or reduce density in the high-density class, resulting in 3,988 acres or 28% of the project area and is within HRV (20-40%). This is less area than alternative 2 (30%) because thinning intensities from alternative 2 is greater than alternative 3 resulting in treatment units moving into the low-density class instead of the moderate density class.

Low Density Class: Alternative 3 would increase the area within the low-density class to 30% (4,286 acres), 7 % less area then alternative two and within HRV (15-35%). Although the amount of area in low density class is within HRV, having more area may be appropriate for the expected conditions and disturbances associated with climate change such as available soil moisture and more frequent fire.

Moist Upland Forest

High Density: Alternative 3 defers treatment in 301 acres of high-density moist forest, resulting in 25% (1,546 acres) and is within HRV (15-30%). Having more forest area in the high stand density class presents an increased risk to disturbance agents, especially considering climate change predicted effects of reducing available soil moisture on these sites.

Moderate Density: Alternative 3 results in 23% (1,430 acres) and is below HRV (25-60%). Alternative 2 maintains less area (16%) in the moderate density class as proposed treatment reduces more area from the high-density class into the moderate density class.

Low Density: Alternative 3 would with result 51% (3,179 acres) of moist forest in the low-density class and is above HRV (20-40%). Alternative 2 would reduce more acres (631) from both high and moderate stand density classes into the low-density class compared to Alternative 3. Stands with low density may be appropriate given directional climate change will likely impose stand moisture restriction in these forest (Johnson 2017).

Dry Upland Forest

High Density: Alternative 3 would reduce density in 861 acres of upland forest in the high-density class, resulting 2110 acres or 26% of the area, compared to alternative 2 with 20% (1630 acres). Both alternatives result in a reduction from the current condition (36%) but would remain over HRV (1-15%). Alternative 3 has more area in this class because late and old dry forest are not treated in this alternative. Climate change is expected to decrease the amount of water availability on these sites which will increase the intensity of competition across the stand and contribute to their vulnerability to disturbance agents and wildfire.

Moderate Density: Alternative 3 treatment results with 34% (2,815 acres) in the moderate stand density class, which is like Alternative 2 (34%, 2,792). Both Alternatives would exceed HRV (15-30%). Without treatment this area would likely grow into the high-density class in the next 20 years, expanding the overly abundant amount of area in high density class above HRV and will likely need to be treated again.

Low Density: Alternative 2 reduces acres from the high and moderate stand density classes into the low-density class resulting in 46% (3,792 acres) and Alternative 3 would result in 40% of the project area (3,289 acres) in low density stands. Both alternatives would increase acres within the low stand density class to conditions within HRV (40-85%). Moisture currently is limited across these sites and is expected to intensify with directional climate change (Powell 2014). Stands not experiencing intertree competition have the best chance of maintaining vigor and decreasing the risk to mortality agents.

Composition

Cold upland forest

Alternative 3 would treat 1,546 acres of late seral species cover and 1,485 acres of lodgepole pine cover to promote early seral species. Late seral species cover types would be reduced to 43% (6,053 acres) and is within HRV (20-50%); lodgepole pine cover types would cover 5,108 acres or 36% and within HRV (25-45%); and 21% (3,031 acres) of early seral cover types and is within HRV (10-35%).

Moist Upland Forest

Alternative 3 would convert 1,100 acres of late seral species cover and 252 acres of lodgepole pine cover into early seral cover. Late seral species cover would be reduced to 26% (1,589 acres) and is within HRV (16-40%); lodgepole pine cover would be reduced to 17% (1,056 acres and is below HRV (25-45%); early seral cover would increase to 57% (3,572 acres) in moist forest and within HRV 30-75%). Replacing lodgepole dominant stands with early seral species improves resiliency to moisture limiting conditions (Johnson, 2017).

Dry Upland Forest

Alternative 3 treats close to the same proportion of Dry Upland Forest as Alternative 2 with exception to dry upland forest in late and old structure. Alternative 3 would convert 480 acres of late seral species cover and 36 acres of lodgepole pine cover into early seral cover. Late seral species cover would be reduced to 55% (4508 acres) and is within HRV 16-40%; lodgepole pine cover would be removed as it is not resilient on these sites; early seral cover would increase to 45% of dry upland forest (3,707 acres) and is below HRV 56-100%. Past management has created conditions that does not promote the establishment early seral species or retain them. Future mechanical treatments and prescribed fire will be necessary to create and maintain forest area that is conducive to supporting early seral species.

Forest Structure

Old Forest Multi Strata

Alternative 3 would not reduce OFMS in any PVG.

Old Forest Single Strata

Alternative 3 treats 539 acres of upland forest described as stands in the UR structure stage that will develop into OFSS after treatment in the next 10-20 years. For conceptual purposes, 10-20 years after implementing Alternative 3, and assuming no disturbances occur in the project area, dry upland forest would contain 326 acres or 4% HRV (40-65%), Moist Upland Forest would contain 116 acres or 2% HRV (10-20%), and Cold Upland Forest would contain 97 acres or 1% HRV (5-20%). Clearly, this forest structure type is limited across the landscape and will require additional mechanical, hand, and prescribe fire treatments to reach desired conditions.

Understory Reinitiation and Stem Exclusion

Alternative 3 treats 6752 acres, 769 acres commercially and 7,533 acres noncommercially within these structure types. Treatment increases the acres in UR, and decrease the number of acres in SE, resulting with UR overrepresented in each upland forest compared to HRV: cold forest is over HRV (10-25%) at 9164 acres or 65%, dry forest is over HRV (0-5%) with 4974 acres or 61% and moist forest is over HRV (15-25%) with 3065 acres or 49%. With the exception of the 539 acres that will develop into OFSS in the next 10-20 years, the amount of UR would increase across the area because intermediate treatments, such as improvement harvest will maintain conditions in the UR structural stage, time along with post treatments such as periodic prescribed fire will help develop these stands into late and old structure.

Implementing Alternative 3 will accelerate development into late and old structure and create openings throughout stands in the SE structural stage and convert them into UR. The number of acres in SE across the upland forest is reduced; cold forest is within HRV (15-30%) with 16 % area or 2226 acres, moist forest is with HRV (20-30%) with 26% area or 1602 acres and dry forest is above HRV (10-20%) with 22% area or 1833 acres. Openings in these stands is expected to regenerate and create a new canopy layer converting into UR.

Stand Initiation

Alternative 3 eliminates HSH treatment and limits HPO treatments to only areas within strategic fuel break objectives. 84 acres of SI are created in Alternative 3, 28 acres in Moist ,51 acres in cold 5 acres in dry forest. As with alternative 2, Alt. 3 does not substantially move any upland forest area towards SI and will remain deficient compared to HRV. These treatments jump on opportunities to enhance regeneration of early seral species where they are present and address root disease. All upland forest types will lack area within SI resulting with 5% (297 acres) of moist (HRV 20-30%), 288 acres or 4% in dry (HRV 15-30%) and 380 acres or 3% in cold (HRV: 20-45%).

Insect and Disease Susceptibility

High, Moderate and Low Susceptibility Ratings

Alternative 3 may reduce susceptibility risk across upland forest from high or moderate to low, it aims to reduce 2% risk to cold forest area, 4 % risk for moist forest area, and 10% risk to dry forest area. Alternative 3 would result with the amount of area of cold and dry forest is at or below recommended susceptibility risk to reflect HRV. The amount of moist forest is mostly within the expected susceptible risk. Having more area in the low susceptibility risk rating than what was historically expected may be appropriate with expected changes in water availability associated with climate change.

Silvicultural Findings of Compliance with Laws, Regulations, and Policy

Alternatives 2 and 3 all comply with the goals for timber in the 1990 Wallowa-Whitman National Forest (WWNF) forest plan as amended by providing for production of wood fiber to satisfy national needs and benefit local economies consistent with multiple resource objectives, environmental constraints, and economic efficiency. Opportunities for fuelwood gathering for personal and commercial uses would be available within the project area. These alternative meet the forest plan standards and guidelines for timber because prescription have been prepared and reviewed by a certified silviculturist, meet the silvicultural needs of the stands being treated including stand structure and species composition, limit created opening sizes, utilize the appropriate yarding system for stand and ground conditions, and call for pre-commercial thinning of young stands to accelerate their growth. All action alternatives also propose to harvest timber on lands suitable for timber management (Table 11).

Literature cited:

Barrett, J.W. (1979). Silviculture of ponderosa pine in the Pacific Northwest: the state of our knowledge, *Gen. Tech Rep. PNW-97*, Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, 106.

Cochran, P.H., Geist, J.M., Clemens, D.L., Clausnitzer, R.R., & Powell, D.C. 1994. Suggested Stocking Levels for Forest Stands in Northeastern Washington. *Gen. Tech Rep. PNW-*

RN-513, Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 8, 21.

Cochran, P.H.; Dahms, W.G. 1998. Lodgepole Pine Development After Early Spacing in the Blue Mountains of Oregon. Res. Pap. PNW-RP-503. Portland, OR: U.S Department of Agriculture, Forest Service, Pacific Northwest Research Station. 20..

Cochran, P.H.; Seidel, K.W. 1999. Growth and yield of western larch under controlled levels of stocking in the Blue Mountains of Oregon. Res. Pap. PNW-RP-517. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 31.

Dwire, K. A., *et al*. 2016. Riparian fuel treatments in the western USA: Challenges and considerations. Gen. Tech. Rep. RMRS-GTR-352. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 156 p.

Fettig, C. J.; Klepzig, K. D.; Billings, R. f.; Munson, A. S.; Nebeker, T. E.; Negron, J. F.; Nowak, J. T. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. Forest ecology and management. 238(1-3): 24-53

Graham and McCaffrey. 2003. Influence of forest structure of wildfire behavior and the severity of its effects. USDA Forest Service, Rocky Mountain and North Central Research Stations.

Haugo, R. D., and C. B. Halpern. 2007. Vegetation responses to conifer encroachment in a western Cascade meadow: A chronosequence approach. Canadian Journal of Botany. 285.

Halofsky, J. E., Peterson, D.L., eds. (2017). Climate change vulnerability and adaptation in the Blue Mountains. *Gen. Tech. Rep. PNW-GTR-939,* Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 29.

Johnston, J. D, Bailey, J. D., & Dunn, C.J. (2016). Influence of fire disturbance and biophysical heterogeneity on pre-settlement ponderosa pine and mixed conifer forest. *Ecosphere,* 7 (11), 14-16.

Johnston, J. D. 2017. Forest succession along a productivity gradient following fire exclusion. *Forest Ecology and Management*, *392*. 1,50, 54, 55.

Marshall, John. 2019. Reconstructing the 1930's-Era Osborne Panoramas. [powerpoint].

Powell, D. C. 1999. Suggested Stocking Levels for Forest Stands in Northeastern Oregon and Southeastern Washington: An Implementation Guide for the Umatilla National Forest USDA Forest Service, Pacific Northwest Region, Umatilla National Forest. 300 p.

Powell, D. C. (2019). Range of Variation Recommendations for Dry, Moist and Cold Forests. *White Paper F14-SO-WP-Silv-03*, U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Umatilla National Forest, 12, 25.

Powell, D. C. (2014). Active Management of Dry Forest in the Blue Mountains: Silvicultural

Considerations. *White Paper, F14-SO-WP-SILV-4*, U.S Department of Agriculture, Forest Service, Pacific Northwest Region, Umatilla National Forest. 12, 99, 104-105.

Powell, D. C. (2019). Active Management of Moist Forest in the Blue Mountains: Silvicultural Considerations. *White Paper, F14-SO-WP-SILV-7*, U.S Department of Agriculture, Forest Service. 80-81, 84.

Schaedel, Michael S.; Larson, Andrew J.; Affleck, David L. R.; Belote, R. Travis; Goodburn, John M.; Wright, David K.; Sutherland, Elaine Kennedy. 2017. Long-term precommercial thinning effects on Larix occidentalis (western larch) tree and stand characteristics. Canadian Journal of Forest Research. 47: 861-874.

Schmitt, Craig L. 1994. Forest Tree Diseases. 29 .

Scott, Donald W. 1996. A Rationale and Procedure For Determining Imminent Susceptibility Of Stands To Insects In the Blue And Wallowa Mountains Of Southeastern Washington and Northeastern Oregon. USDA. Forest Service. Pacific Northwest Region. Blue Mountains Pest Management Zone. BMZ-96-15. 17.

Stine, P., Hessburg, P., Spies, T., Kramer, M., Fettig, C. J., Hansen, A., Lehmkuhl, J., O'Hara, K., Polivka, K., Singleton, P., Charnley, S., Merschel, A., & White, R. (2014). The ecology and management of moist mixed-conifer forests in eastern Oregon and Washington: a synthesis of the relevant biophysical science and implications for future land management. *Gen. Tech. Rep. PNW-GTR-897*, Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 147-152, 254.

Urness, Zach. 2020. Oregon's 2020 wildfire season brought a new level of destruction. It could be just the beginning. *Salem Statesman Journal*, Salem, OR. October 30, 2020.

USGS. Eruption History for Mount Mazama and Crater Lake Caldera. Eruption History for Mount Mazama and Crater Lake Caldera. https://www.usgs.gov/volcanoes/crater-lake/eruption-history-mount-mazama-and-crater-lake-caldera. Accessed 2020.

USDA Forest Service. (1995). Revised interim direction establishing riparian, ecosystem and wildlife standards for timber sales; Regional Forester's Forest Plan Amendment #2. Portfand, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, 14.

Wyckoff, Peter H.; Clark, James S. 2005. Tree growth prediction using size and exposed crown area. Can. J. for. Res., Vol. 35: 13-20.